Index

N-Acetylhomocysteine thiolactone, lipopigment degeneration 308–12, 316 *see also* citiolone
Acid desoxyribonuclease 347
Acid fastness, lipofuscin 371, 372
Acid hydrolase 343
Acid phosphatase 347
  staining 229, 347
Acid ribonuclease activity 347
Adult amaurotic idiocy 262
Age
  lipofuscin 39
  and performance 399
Age pigment *see also* lipofuscin
  autofluorescence 23
  biological markers 142–5
  emission and excitation spectra 166
  fluorescent 11–17
  fluorophores 23–34
  free-radical damage 142
  fungi and heavy metal pollution 147–53
    determination 149
  Neurospora sp and malonaldehyde 165–83
  ovine and ceroid lipofuscinosis 206
  properties, ovine 208–10
Age-related fluorescence substance (ARFS) 88, 89
  lipofuscin correlation 90
Aging *see also* cellular
  characteristics 394
  measurement 86
  normal changes 75
  rate, acceleration 406, 407
  waste product theory 278, 279
Albumin synthesis 398, 399
Alcian blue 349, 352
  tissue bound sulphur 352, 353
Aldehyde fuchsin 349, 350
  performic acid oxidation 351
  types 351
Aluminium 9–11
  and membrane structure 9
Alzheimer's disease *see also* senile dementia
  aluminium 10
  astrocyte lipopigment 252, 256
  neuronal lipofuscin granules 252, 255
Amino acids
  sulphur containing and RPE 118–22
  TBA reactivity 18
Amphibia, brain melanin staining 364
  tyrosine 365
Animal models *see also* rats
  Batten's disease 187
  English Setter dogs 185–213
  sheep 199
ANOVA 283
Antioxidant *see also* Vitamin E
Argentaffin reaction 370, 379, 381
Argyrophilic methods 381
Aryl sulphatase activity 347, 348
Aspartylglycosaminuria 255
Astra blau 353
Astrocytes
  age changes and diet 62, 63
  hereditary ceroid lipofuscinosis 189, 190
Autofluorescence 373
Autophagocytosis and lipofuscin formation 87

Basic blue 3
  calibration 30
Batten's disease (Stengel–Batten–Spielmeyer–Vogt's disease) 185, 186
  brain biopsy 223

(Batten's disease *cont.*)
brain loss 223, 226
cerebral atrophy 217
end stage,
autofluorescence 223, 224
neuron filling 223, 224
enzyme deficiency 225, 226
features 186, 219
first descriptions 218, 219
incidence 219
inheritance 220
membrane bound inclusions 223, 225
retinal changes 219
stored material 220
symptoms 221
syndromes 219
Batten–Kufs disease 259
Behaviour and lipofuscin 80
Biopsy
brain 223
ceroid lipofuscinosis, neuronal 271
Black system, brain 252
Bleomycin assay 5, 6
Brain
lipid peroxidation and diet 59, 60
vitamin E levels and diet 54–6
Brain 22:5ω6, age, sex and diet in rats 77, 78
Brain 22:6ω3
age, sex and diet in rats 77, 81
precursors 81
Brown bowel disease 249, 250

Caenorhabditis briggsiae
ferritin in cuticle 160, 161
fluorochromes 156
glycocalyx and procaine 160, 161
and red blood cell aging 160
Caenorhabditis elegans
age pigment granules 157, 158
aging, rapid model 155–62
culture 155
electron microscopy, intestine 157
life cycle 155
Carbodiimide reaction of Geyer 363
Carbohydrates, TBA-reactivity 18
Carboxyl groups
carbodiimide reaction 363, 364
intragranular 358–64
Catecholamine histochemistry 368–70
Cell culture
canine lipofuscinosis 302, 303
media 302, 303
N-2A 304, 306, 307
neuronal aging 301–18
neurons 302
retina 307–10
spinal ganglia 310
Cellular aging mechanisms 402–6
Cellular functions 396, 397
classes 397, 398
damaging factors 400–2
efficiency and age 399, 400
multiplication 399
turnover 398
Cellularity and diet type 62, 63
Centrophenoxine 297
see also meclofenoxate
aging rate 407
hydrolysis products 158
lipofuscin accumulation in nematodes 158, 159
lipofuscin content 116, 142
RPE lipofuscin 126–8
Torpedo sp lipofuscin 141, 142
and vitamin E interaction 116, 117
Cerebellar circuit
diagram 324
species differences 325
Cerebellar cortex *see also* Purkinje cells
autofluorescence in rats 323, 325
light microscopy 327, 328
granules 326
parallel fibre numbers 333, 334
boutons 333
synaptic density 333, 334
Cerebellar vermis *see also* Purkinje cells
lesion effects 322, 323
lobule X, fluorescence microscopy 323
mossy fibre afferent 322
section 322
Ceroidogenesis models 42

Ceroid-lipofuscinosis *see also* Batten's disease
historical developments 220
neuron lipopigment 199
pathogenesis 198
subtypes, features 198, 219
Ceroid-lipofuscinosis, hereditary canine 225
autofluorescent material 193
Batten's disease comparison 192, 193
cell culture 302, 303
ceroid detection time 192
course 189
drug effects 193
electroencephalography 192
English Setter model 185–213
enzymes 191, 192
nerve cell changes 189–91
non-vascular lipopigments 265
onset age 189
pigment accumulation 191
retina, lipopigment 307–10, 316
spinal ganglia 310–12
centrophenoxine 312
lipopigment degeneration 310–12
treatment regimes 187
vitamin E 188
Ceroid-lipofuscinosis, neuronal 186
adult *see* Kuf's
animal models 187
appendix fixation 229
brain biopsy 259, 271
classification and features 186
curvilinear lipopigment types 228, 258, 259, 263
prenatal 273
diagnosis 270, 271, 273
tissues 271, 273
early juvenile *see* Lake–Cavanagh
granular lipopigments 262
significance 262, 263
heterophagocytosis 228
infantile 259, 260 *see also* Haltia–Santavuori
juvenile *see* Spielmeyer–Sjogren
late infantile *see* Jansky–Bielschowsky
lipopigment morphogenesis 268
lipopigment ultrastructure 258–73
lymphocytes 260, 266, 267, 271, 273
protracted juvenile *see* Hauervorden
rectal biopsy 271
red blood cell destruction 230–8
retinal cell structures 307, 308
subtypes 186, 258
Ceroid-lipofuscinosis, ovine 197–213, 225
age pigment 208–10
inborn errors 212
lipopigment isolation 199, 201
electron micrographs 200
lipopigment lipids 203–6
fluorescence 206, 207
and lipofuscin 213
proteins 206–9
liver phospholipids 201, 202
metabolic defect 210
neutral liver lipids 203
origin of name 212
Ceroid pigments 38
associations 222
autofluorescence 42
definition 249
factors affecting accumulation 41
intracellular amounts 41, 42
and lipofuscin 39–43
vitamin E deficiency 41–3
Chromium deficiency 118
RPE lipid drops 119, 122
RPE lipofuscin 118, 121
Chromogens, compounds forming 18, 19
Chronic organic brain disease (COBD) 76
causes 76
Citiolone *see also* N-Acetylomocysteine-thiolactione
superoxide dismutase stimulation 141
Torpedo sp lipofuscin 141, 142
Copper
complexes and membrane phospholipids 10
Corollospora maritima test 149
fluorescent age pigments 13–17
free radical generation 145
intraneuronal pigment uptake 378

(Copper *cont.*)
loosely-bound 6
oxygen metabolism 4, 5
pollution and *Torpedo* sp tissue 143
protein binding 9
protein fluorescence 8, 9
surface and bottom sea water 150, 151
Corollospora maritima 145
age pigment microscopy 150, 152
aging model 152, 153
copper sensitivity 149, 150
culture 149
iron sensitivity 149, 150
sea water level pollutants 151
test for pollution 149
Correction factors 30
Neurospora fluorogens 172
Cytotoxicity and lipid peroxidation 45

DDD method, fixation 353
Dermal axonal dystrophy 267
Desferrioxamine (Desferal) 14, 15
Diene conjugates, diet and lipid peroxidation 59, 60
Diet 37–68
experimental, rat 49, 79
fat peroxidizability 79
fat types, effects in rats 48–67
composition 49
lipid peroxidation 67
morphometric analyses 62–6
neuronal lipofuscin 78, 80
tissue lipid fatty acids 46, 47
Dietary antioxidants and lipofuscin 113
Diglycinyliminopropene 182
Diglycinyl 1 CSB in lipofuscin fluorophores 33
Dihydroergotoxine
hippocampus lipopigments 96, 98
lipopigment accumulation 93–9
administration 94
cells 94
Purkinje cell lipopigment 96, 97
1,4-Dihydropyridine formation of fluorescent 16, 17
p-Dimethylaminobenzaldehyde, protein reaction 365, 366
Dimethylaminoethanol, lipofuscin in nematodes 158, 159
DNA and dietary fat 54
Drugs
aging longevity 156–62
neuronal lipopigment 93–9

Electric lobes *see also Torpedo* sp
discharge 134
Electroencephalography, ceroid lipofuscinoses 192, 193
Electron microscopy
fixation 303
microglia 102, 106, 107
Electroretinogram thresholds and dietary deficiencies 119, 121
Endoplasmic reticulum, rough
supraoptic nucleus and age 288
Erythrocyte
crystals 230, 234, 236
curvilinear profiles 230, 232
degradation features 230, 231
digestive vacuole 230, 233
fragment sizes 232
lysosomal digestion 230, 235
Erythrocytophagocytosis 236
Esterase activity 348
Experimental lesions, cerebellum 322, 323
Extraction procedures, Folch 26, 28

Fabry's disease, lysosomal lipofuscin storage 239, 241
Falck–Hillarp histofluorescence 368, 369
catecholamine 369
Ferritin, iron storage 4, 7
Fluorescence
instrumentation 27, 29–34
Neurospora sp pigments 168, 169
non-lipid molecules 17–19
polarization 169
Fluorogens
molecular weight determinations 178, 179
quantum yield 181

Fluorometric methods, lipofuscin measurement 87, 88, 90
Fluorophores *see also* ceroid, lipofuscin
blue emitting 44
Free radicals
cell death mediators 302
initiation scheme 17
lipid peroxidation 316
mitochondria damage 302
oxygen radical damage 11, 12, 400–2
protection and lipofuscin 140, 141
theory of aging 12, 75, 160
Functional processes 396, 397
Fungi
fluorescent pigments 148
senescence 167

Gangliosidoses (GM)
lipofuscin 238–40
lipopigments 255
perikaryon 258
Gaucher's disease 243
lipofuscin storage 239, 240
Gel permeation chromatography
Neurospora sp pigments 170, 171, 178–81
Genetic effects, aging 75
Gerontology, theoretical 393–408
questions 396
summary 395
tasks 400
Globoid cell leukodystrophy, needle-like bodies 257, 258
β-Glucuronidase activity 348
Glutathione, tissue measurement 114
Glutathione peroxidase 401
GMP, cyclic and nematode growth 160
Golgi, age effects 288, 289
Gomori's acid phosphatase 343, 345, 346
Gulf of Naples, sea water collection 148, 149

Haemophagocytosis, appendical macrophages 229, 230
Hallervorden disorder 258, 268
lipopigment ultrastructure 270
Haltia–Santavouri disorder (infantile)
features 186, 219
lipopigment ultrastructure 259, 260
Heart
fluorochrome accumulation 156
vitamin E levels and diet 56, 57, 62
Hepatocytes
acid lipase deficiency 239, 240
age changes and diet 63, 64
lipofuscin and age 65, 66
lipofuscin evaluation 238
lipofuscinogenesis 244
protein synthesis 398
Hereditary photoreceptor cell degeneration
lipofuscin accumulation 115, 125, 126
retinal appearance 115, 116
Heterophagocytosis 228
High performance liquid chromatography (HPLC) 280, 281
equipment 281
Hippocampus
aging and lipopigment 96, 98
CA2 granules 102, 104
CA3 region study 95, 99
CA4, fluorescence 102, 105
osmiophilic material 104, 106
Holistic process 397
Homeostasis maintenance 397
Housefly, lipofuscin fluorescence 89
Huntington's chorea 252
Hydrogen peroxide 318
Hydroperoxyl radical 2
3-Hydroxyacrolein 166
Hydroxyl radicals, formation and reactivity 3
Hypothalamo-neurohypophyseal system *see also* neurohypopophysis
function indicator 297
role 279
study problems 296

Inferior olive, aldehyde pathway 355, 356

Intracellular density and age 405
Iron
  body fluid, loosely-bound 6
    and damage 7
  complexes 3, 5
  Corollospora maritima test 149, 150
  ferrozine-reactive 7, 8
  fluorescent age pigments 13–17
  haem 7, 8
  mal-placed 5
  melanin uptake 377
  membrane lipid peroxidation 14
  non-haem 7
  overload 6
  oxygen metabolism 4, 5
  sea water levels 150, 151
Iron catalysed Haber–Weiss reaction 3, 6

Jacob–Creutzfeldt disease, lipopigments 252
Jansky–Bielschowsky disorder
  appearance 221
  curvilinear bodies 263
  features 186, 219, 220
  myoclonal body 263

Kufs disease 186, 220, 259
  cerebral cortex lipopigments 260, 261
  extraneuronal lipopigments 261
  lipopigments ultrastructure 260, 261
  pre-mortem diagnosis 261

Lake–Cavanagh disorder 258, 268
  lipopigments 269
  lymphocyte fingerprint body 269, 273
Least significance difference (LSD) 283
Life span
  antioxidants 316
  diet in rats 52, 53
  indices 52
  lipofuscin accumulation 112, 113
Linoleic acid, dietary 49, 50
Lipid auto-oxidation 4
Lipid droplets, RPE and dietary deficiencies 118, 119, 122
Lipid peroxidation 11
  brain, dietary groups 59, 60
  copper salts and membranes 13
  cytotoxicity 45
  desferrioxamine inhibition 14, 15
  fluorescence and lipofuscin 25
  fluorescent age pigments 13–17
  free radical flux 166
  in vivo estimation 50
  iron-EDTA mechanisms 12, 13
  iron salt stimulated 14
  liver, dietary groups 60, 61
  necrotic cell changes 45, 46
  pathogenic implication 62
  potential and dietary vitamin E 57–9
  species 166
Lipids
  dietary fats in rats 53, 54
  TBA and reactivity 18
Lipofuscin
  accumulation
    free radicals 140, 141
    Purkinje cells 321–35
    rates and lifespan 112, 113
    significance 129
  acid fastness 371, 372
    brain areas 371
  age-dependent granules 40–2, 79
  age and diet effects 67
  age-related accumulation 89
  aldehyde generation 355
  argyrophilia 379
  autofluorescence 373, 374
    and staining 374
  autophagocytosis 39
  bleached neuromelanin 376
  bleaching 342
  blindness 23, 24
  carboxyl group location 358–64
  cell changes and age 64–7
  cell function 295
  central nervous system distribution 354
  cerebellar cortex 328–30
  ceroid lipofuscinosis, ultrastructure 250
  ceroid similarity 39–43

colour 372
deficiency effects 76
definition 249
dietary deficiency and RPE 118, 121
dietary 22 : 3ω3 77
electric lobes, Torpedo 135–7
emission maxima 87, 88
extracellular 40, 41
fluorescence features 25
fluorescence spectra
  correction 30, 31
  features 88, 89
  identity 90
  yellow and blue 88, 89
fluorophores 24
  separation 28
  structures 33
formation 76, 87
  chemical model 88
granule membranes 251
granule, paracrystalline 251, 252
granules and age 78
granule size and age 40
heart 28
hepatocyte evaluation 238
histochemical tests 345–8
historical studies 341, 342
light scattering capacity 374
literature 38
metal ion uptake 377–82
nematode accumulation 156–9
neuronal accumulation 76, 258
neuron perikarya, age and diet 78, 80
osmiophilia 381
oxidation 355
PAS positive 354
pollution effects and *Torpedo* 144, 145
properties 39
protein related reactions 365, 366
Purkinje cell number 66, 67
quantification 85–91
  biochemical 87
  fluorometric methods 87, 88, 90
  Torpedo and age 137–9
production, factors affecting 139
reducing capacities 378
removal 101 *see also* osmiophilic waste
retinal degeneration 125, 126
retinal pigment epithelium and centrophenoxine 126–8
  factors affecting 111–30
  sources 24
Schiff reaction 355, 356
sheep brain 199
soluble lipid-free 352
spontaneous production 244, 245
staining 342, 349–51
  bichromatic 359
  brain areas 359
  low pH 358
sudanophilic reactions 366
theories of activity 278
ultrastructure 251
ultraviolet autofluorescence 86, 87
unsaturation evidence 354–8
vitamin A and E deficiency in RPE 123
vitamin E effects 43–5
  supplementation 44
volume density, Purkinje cells 332
Lipopigment *see also* ceroid, lipofuscin, neuromelanin
bodies and mitochondria 312–15
electron micrographs 200
isolation 201
properties 201, 202
protein and lipid proportions 208
Lipopigmentogenesis and lysosomes 239
Liver
  cell numbers and diet 63, 64
  lipid peroxidation and age 60, 61
  vitamin E levels and diet 55, 56
Locus coeruleus, pigment loss in SDAT 81
Lymphocytes, ceroid lipofuscinosis diagnosis 271, 273
Lysosomal diseases, lipopigment 255
Lysosomal enzyme activities 343
Lysosomal enzymopathies 229
  lipid droplet matrix 267
  lysosomal inclusions 257, 268

Lysosomal proteolysis 212
Lysosome
  autophagic 343
  GERL origin 344
  types 344

Macrophage
  erythrocytophagocytosis 230–8
  haemophagocytosis 229, 230, 242–4
  lipopigment storage ultrastructure 230–8
  lysosomal residual bodies 242
  residual body 237
Malonaldehyde
  carcinogen 183
  catabolism 182
  copper and iron in *Corollospora* 150
  detection 170
  dietary vitamin E 57
  enol tautomer 166
  in vitro production 46
  polymerization 183
  polymerized 166
  synthetic 171
Marchi method 102
Meclofenoxate *see also* Centrophenoxine
  chronic effects 99
  hippocampus lipopigments 96, 98
  lipopigment accumulation 93–9
  Purkinje cell lipopigment fluorescence 96, 97
Melanin, reducing reactions 378
Melanolysosome formation 252, 253
Melanosomes, goldfish 381
Membrane
  intracellular iron and water 404, 405
  lipid fluidity 403
  potassium permeability 404
  protein diffusion 404
  protein distribution 403
Membrane hypothesis of aging 393–408
  summary 402, 403
Metachromatic leukodystrophy
  lipofuscin 239, 241
  lipopigment 255, 257
  membranous bodies 257
Methaemoglobin, ferrozine-reactive iron formation 7, 8
Methionine and RPE lipofuscin 121
Mice
  C57BL/1crfa 279
  maintenance 279
  metabolism studies 282, 283
Microglia
  age changes and diet 62, 63
  diseased neuron removal 102
  electron microscopy 106, 107
  granule appearance 102, 105
  lipid filled and neurons 102, 107
  lipid uptake route 102, 108
  lipofuscin 102, 106
Mitochondria
  age-related decrease 314
  degenerating, spinal ganglia 310, 312, 315
  free radical damage 302
  lipopigment body association 313
  lipopigment ultrastructure 304, 306
  N-2A cell age 304
  osmiophilic body accumulation 304–7
  pigment body association 312, 313
  senescence 306, 307
  supraoptic nucleus and age 289–91
Model, theoretical gerontology 394, 395
Morphometric analyses 51, 303
  fat diet 62–6
Motor neurons, pigment filling 102, 103
Mucolipidoses 255
  lipopigments 262
  lymphocytic lysosomal vacuoles 266
Mucopolysaccharidoses 238
  lipofuscin 238
    storage 239, 240
  lipopigments 255
    fingerprint bodies 258, 264–6
  lymphocyte, fingerprint profiles 264
    lysosomal vacuoles 265
Myoclonus body 263
Myocytes
  age changes and diet 64
  lipofuscin and age 65, 66

Nematodes, screening value 155
Neocerebellum 322

Neurohypophysis
hormones and age 280
metabolic effects and age 293, 294
neurosecretory endings 289–95
salt loading 291, 294
neurosecretory granules 282
neurosecretory swellings and age 289–95
volume fraction 291, 295
peptide hormone and mouse age 293
sample preparation 280
Neuromelanin 252, 253, 342
acid fast staining 371, 372
aldehyde fuchsin 352
argentaffin reaction 380
argyrophilic methods 381
brain mapping 368, 369
carboxyl groups 361
catecholamine histofluorescence 370
colour 374, 375
diammine silver reaction 380
ferrous ion binding 377
fluorescence 376
histochemical tests 348
intraneuronal granules 357
light scattering 375
lipofuscin relationship 376
neuron distribution 370
Nile Blue sulphate 361–3
non-bleaching oxidation 357, 358
oxidative bleaching 375, 377
PAS reactivity 357
reducing capacities 378
sequential oxidation 358
staining 352, 361, 370
substantia nigra 252, 254
rhesus monkey 346
Sudan staining 366–8
sulphur 349
unsaturation 357
Neuromelanogenesis, optical properties 372–7
Neuronal aging 301–18
energy deficit 301
free radical damage 301, 302
models 301, 302
trophic defect 301
Neurons, residual heat 402

Neurospora crassa
age pigments 16, 165–83
factors affecting 167
fluorescence 168, 169
aging study 147, 148
culture 167, 168
fluorogens 168–83
absorbance spectra 173, 175
acid-base titration 173, 174
analysis 168–70
elution volume 170
excitation and emission spectra 172, 173
extraction 168
fluorescence properties 176, 177
gel permeation chromatography 178–81
isolation methods 178
molecular weight determination 178–80
partition coefficients 177
polymalonaldehyde 172, 173
reactivity 179, 180
S-4 172, 173
Schiff bases 182
senescence 176, 178
thin layer chromatography 169, 170, 175, 176
inositol auxotroph 167
leucine auxotrophs 167
Niemann–Pick disease
lipofuscin 238, 239
lipopigments 255
ultrastructure 262
Nile Blue sulphate
brain regions 361, 362
carboxyl bonding 364
histochemistry 361
meningeal melanin 364
methods 359, 360
reevaluation 363
Nucleic acid, TBA reactivity 18

Oligodendrocytes, age changes and diet 62, 63
Organelles
age changes and diet 64
relative volumes 331, 332

(Organelles *cont.*)
volume and age, Purkinje cells 330, 331
Osmiophilic waste *see also* microglia
cellular transfer 108
removal and microscopy 101–9
Oxygen
active intermediates 2
electrons 1
global, free molecular 1
organic radicals 3, 4
Oxygen metabolism, iron and copper proteins 4
Oxygen radicals 1–19
attack, consequences 401, 402
damage 11, 12, 400–2
generation pathways 401
$O\cdot_2^-$ formation 2
Oxygen toxicity, free radical theory 12
Oxytocin
concentration and mouse age 293
radioimmunoassay method 281, 282

Panagrellus redivivus, fluorochrome accumulation 156
Parachlorophenoxyacetic acid, lipofuscin in nematodes 158, 159
Parietal cerebral cortex neuron, lipofuscin and age 65
Parry's disease 220
Pathoklise 335
Phagocytosis and RPE lipofuscin 115, 116, 124, 125
Phagosomes, RPE and deficiencies 122
Phenanthroline-available copper 6
p-Phenylenediamine-mediated peroxidase in ceroid lipofuscinosis 191, 192
Phenylhydrazine test 178
Phospholipids
ceroid-lipofuscinosis, sheep liver 201, 202
lipopigment in ceroid lipofuscinosis 203, 204
Photoreceptor outer segments
docsahexaenoic acid 129
renewal and lipofuscin 124
vitamin E deficiency 118, 119
Podospora anserina aging study 147
Pollution
free radicals 142
Gulf of Naples 143, 144
heavy metal indicators 147–53
Polymalondialdehyde
absorbance spectra 173, 175
acid base titration 173, 174
fluorescence properties 176, 177
fluorescent, scheme 16
lipofuscin fluorophore 33
molecular weight 181
Polyunsaturated fatty acids (PUFA)
aging in mice 47
oxygen reaction 3
photoreceptor outer segments 129
tissue fatty acids 47
Pompe's disease, lysosomal storage 239, 240
Premature aging 11, 12
Prenatal diagnosis 273
Procaine, nematode ferritin 160, 161
Protein
blue fluorescence and copper 8, 9
lipopigment in ceroid lipofuscinosis 206–9
molecular weight 207–9, 211
tissues 208
photo-oxidation and fluorescence 18, 19
sulphur containing, staining 365
synthesis 405, 406
Purkinje cells
age and lipofuscin 65, 66
autofluorescence 326, 327
cerebellar diagram 324
dendritic tree 333, 335
density and age 66, 67
diameter, volume and age 328
endoplasmic reticulum 328, 329
examination 95
hereditary ceroid lipofuscinosis 190, 191
light microscopy 327, 328
lipofuscin accumulation 321–35

lipopigment fluorescent intensity 96, 97
lipopigment volumes 93
lobule X 326
mitochondria volumes 331, 332
nucleus volume 331, 332
organelle volume density 330, 331, 335
parallel fibre estimation 333, 334
pigment granule, electron microscopy 327–30
cerebellar areas 330
role 324
Pyramidal cells, examination 95, 96

Quantification, lipofuscin 85–91
methods 86
Quantum counter 29
Quantum yield, fluorescent fluorogens 181, 182
O-Quinhydrone groupings, identification 380

Radioimmunoassay 281, 282
Rats
albino, electroretinogram 119, 121
culture 94
experimental diets 48, 49
Fisher 344 118
Han:Wist 325
Residual bodies 344
Residual heat 402
Retina
Batten's disease 192
cross-section 112
Retinal cells
ceroid lipopigment 307, 308
fragmentation 309, 310
fingerprint structure 308
lipopigment disintegration 308, 309
Retinal pigment epithelium (RPE)
age pigment accumulation 23
amino acid deficiencies 118–22
anatomy 24
ceroid lipofuscinosis 193
diet-induced alterations 113
emission spectra, corrected 30
extract chromatography 26
fluorescence spectroscopy 27
pigment features 28
fluorophores, extraction 26
lipofuscin accumulation, factors 111–30
phagocytes 115
lipofuscin and phagocytosis 124, 125
autoxidation 126
fluorescence micrographs 125, 126
substrates 127
polar fluorophores 33
solvents used 25, 26
spectroscopy 27
study features 113
total luminescence spectra 31, 32
vitamin A and E deficiency 123–5
vitamin E deficiency 117–23
basal infoldings 118, 120
cell height 117, 118
fluorescent microscopy 117
lipid droplets 119, 122
Retinol *see also* vitamin A
dietary and RPE lipofuscin 114, 115
Retinopathies, age-related 130
Rheumatoid arthritis and iron 6, 7
Rhodamine B, spectral calibration 30
RNA synthesis 405, 406
Rod outer segments *see* photoreceptor
RPE *see* retinal pigment epithelium

Salla's disease 255
Santavuori–Haltia *see* Haltia–Santavuori
Sawicki reagent 170, 178
Schiff's base
and age pigments 15
fluorescence excitation/emission spectra 31
formation 15–17
preparation 171
visual pigments 24, 25
Schiff reaction 354
Schmorl's reaction 345, 378
Schwann cell
membrane bound inclusion 266, 269
Batten's disease 223, 225

Selenium deficiency 118
Selenium dependent glutathione peroxidase 114
Senile dementia 223
Senile dementia of the Alzheimer type (SDAT) 75–82
  cell, free radical repair 81
  factors affecting 76
  neuronal systems damaged 81
  nutrition and age 81, 82
Sensory ganglia, pigment types 382, 383
Spectrofluorometers
  calibration 30
  description 29
  spectral bias 29
Spielmeir–Sjögren disorder (juvenile)
  appearance 222
  features 186, 219–21
  fingerprint bodies 264
  granular body patterns 272
  lymphocyte vacuoles 264, 266, 267
  mixed curvilinear-fingerprint bodies 264, 265
  neuronal process, tubules 267, 271
  retinal process inclusion 267, 272
  Schwann cell membranous bodies 266, 269
  urinary sediment cells 266, 270
  zebra body inclusions 266, 268
Spinal cord neuron, lipofuscin 109
Stain
  Bielschowski's silver 342
  lipopigments 229, 345, 346
  macrophages 229
  Nile Blue sulphate 359, 360
  protein-related 365, 366
  rosanilin 356, 357
  sudanophilic 366–8
  sulphur 349, 350
  Ziehl–Nielson 371
Stereological analysis 280
Stress and lipofuscinogenesis 133
Subacute sclerosing panencephalitis, lipofuscin granules 252, 254
Substantia nigra, pigment loss and SDAT 81
Sulphur
  aldehyde fuchsin 349
  intraneuronal pigment 349–53
  staining 349
  tinctorial methods 349
  tissue bound, demonstration 352
Superoxide dismutase 400
  lipofuscin and *Torpedo* sp CNS 140, 141
  Torpedo sp CNS 140, 141
Superoxide production 2
Superoxide driven Fenton reaction 3, 6
Supraoptic nucleus 280
  age in mice 284–6
  endoplasmic reticulum and age 288
  Golgi volume 288, 289
  lipid bodies 287
    and age 289, 292
  lipofuscin volume 286
  mitochondrial profiles 289–91
  neurosecretory granule value 287, 288
  osmotic load 286, 287
Sympathetic ganglia pigments 382
Synaptosome membranes 407

Thin layer chromatography
  age pigment lipids 209
  fluorophore separation 26, 28, 33
  Neurospora sp fluorogens 169, 170
  phospholipids and ceroid-lipofuscinosis 205
Thiobarbituric acid
  molecules and reactivity 18
  reactivity 13, 14
Tissue lipids, dietary fats in rats 53, 54
dl-Tocopherol 49
Torpedo marmorata
  central nervous system 134
  collection and pollution 143, 144
  copper accumulation 143, 144
  electric discharge 134
  electric lobes, microscopy 135–7
  lipofuscin accumulation 135–9, 149
    age 137–9
    antioxidants 141

area covered 139
distribution 136, 137
drug effects 141, 142
morphology 137, 138
mitochondria and pollution 144
newborn, lipofuscin 137, 138
olfactory tract parameters 135, 136
Total luminescence spectra 31, 32
Transition metals 1–19
Tyrosinase 369, 370
Tyrosine hydrolylase 369

Ultrastructural analysis 114

Vasopressin
concentration and mouse age 293
dehydration and osmotic load 294, 296
radioimmunoassay 283
Ventral horn motor cell ceroid body 189, 190
Visual pigments
autooxidation 24
polyunsaturated fatty acids 24
Vitamin
mixtures in diet 49, 50
Vitamin A
ester analysis 15
and lipofuscin 90, 114, 123
photoreceptor cell densities 123, 124
retinal pigment epithelium 114, 115
retinyl ester 123, 125
Vitamin A deficiency
and E deficiency 123–5
photoreceptor death 128
photoreceptor outer segments 128
RPE lipofuscin 123
Vitamin E
age and accumulation 58
brain dienes 61
brain and diet 54–6
cardiac concentrations and diet 56, 57, 62
determination 114
dose, effects 49, 50
and lipofuscin 43–5
liver levels and diet 55, 56
photoreceptor cell density 123, 124
plasma levels and diet 54, 55
requirement and dietary PUFA 47
retinyl ester 123, 125
RPE lipofuscin 123, 124
supplementation 44
tissue lipoperoxidative potential 57–9
Vitamin E deficiency
ceroid pigments 41
disc membranes 118, 119
lipofuscin accumulation 116
lipopigment autofluorescence 253, 256
pigment distribution 44
retinal changes 117–22
and senescence similarity 118
Volume density 331

Weight and dietary fats in rats 50–2
Wolman's disease, lipofuscin 238

Zebra body inclusions 266, 268
Zinc, protective role 10, 11